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ABSTRACT

Objectives: to test the London atlas for dental age estimation in Thai population.

Materials and methods: The London atlas for age estimation was tested in 111 digital panoramic radiographs from the General Police Hospital, Bangkok, Thailand. The sample was composed of children (57♂ and 54 ♀) aged between 4.00 and 15.99 years. The intra- and inter-examiner variations of tooth stage reliability were tested in ~~a random~~ 10% sample using an Intraclass Correlation (ICC). The difference between chronological age (CA) and atlas for dental age (ADA) were investigated using a paired subjects *t*-test. The significance of the difference between CA and ADA was tested using the F-tests of the one-way ANOVA ($P < 0.05$ considered statistically significant). The analysis of variance considered the effects of sex, age group and the interaction between sex and age group. Other analyses included the difference of ADA by age group and the comparison between CA and ADA by sex. SPSS Statistics 24 was used for all analyses.

Results: ADA correlated to CA with a discrepancy of 1.3 years maximum. There was no significant effect of sex (F (1, 87) = 0.278, p = .600), age group (F (11, 87) = 1.032, p = .426) and sex and age group (F (11, 87) = 1.238, p .275) between CA and ADA.

Conclusions: The estimates of dental ages correlate and reasonably reflect the chronological ages of Thai children and adolescents for both males and females from age 4.00 to age 15.99.

Key words: dental age estimation, Thailand, children, London Atlas

Introduction

There are many aspects in which the evaluation of age in the living has become relevant but the most prevalent concern issues include refugee and asylum seekers, criminals and their victims, human trafficking and child pornography [1, 2]. Many techniques have been devised to estimate chronological age including somatic growth measurements and dental development. The somatic development is influenced by genetic, nutritional, climatic, hormonal, and environmental factors but dental development is less affected [3, 4]. Age can be estimated in children and adolescents by development of deciduous and permanent teeth, prior to completion of the third molar [5]. After that, age can only be assessed by regressive changes in teeth [6]. Methodologies for age estimation in children based on tooth development may be divided into those using the atlas approach and those using scoring systems[7].The

London Atlas of tooth development and eruption is an example of atlas composed of designed diagrams of dental age represented by median stages of dental development and alveolar eruption[8]. It represents a substantial improvement on existing atlases facilitating accurate age estimation from developing teeth.

The correlation between the dental age and the chronological age in Thai population has been explored in few studies. A study on dental age estimation in Thai population aged from 6 to 15 years tested the accuracy of *Demirjian et al*. and *Willems et al*. methods [9] and the results showed a strong correlation. Moreover, another study on third molar development in Thai population aged from 9 to 20 years also presented a good correlation[10]. It is important to recognize that more studies should be carried out, therefore, the main aim of this study was to test the London atlas for the dental age estimation in Thai population.

Materials and methods

Ethical approval was granted from the Ethic Review Committee for Human research, Police General Hospital, Bangkok, Thailand (COA No 94/2016). The London atlas for age estimation was tested in 111 digital panoramic radiographs from the General Police Hospital, Bangkok, Thailand. The sample was composed of children (57♂ and 54 ♀) aged between 4.00 and 15.99 years. The chronological age of each subject was calculated by subtracting the date of birth from the date of radiographic examination. Inclusion criteria included good quality panoramic radiographs of healthy children with no medical history of systemic diseases/disorders. Children who presented hypodontia, hyperdontia, gross pathology and previous orthodontic treatment or severe malocclusion were excluded. The distribution between female and male was almost equal in order to avoid age mimicry as seen in table 1. The radiographs were assessed by the main author using the sex-specific application software to determine the developmental and eruption stages of all teeth in the left side, both upper and lower jaws, according to AlQahtani *et. al.* [8]

Table 1: Number of radiographs (N) distributed by age group (years) and sex.

Statistical analysis

A ~~random~~ 10% sample of radiographs was scored by the main author twice in an interval of one week. The same radiographs were scored by the co-author. The inter- and intra-examiner variations were tested using an intraclass Correlation (ICC).

The difference between CA and ADA were investigated using a paired subjects *t*-test. The dental age estimation was defined as how closely chronological age could be predicted, measured as the difference between chronological age (CA) and atlas for dental age (ADA) for

each subject. The chronological age was subtracted from the dental age and a positive result indicates an overestimation and a negative result indicates an underestimation. The significance of the difference between CA and ADA was tested using the F-tests of the one-way ANOVA. The analysis of variance considered the effects of sex, age group and sex & age group [lowest variance, highest variance), ($P < 0.05$ considered statistically significant)]. Other analyses included the difference of ADA by age group and the comparison between CA and ADA by sex. SPSS Statistics 24 was used for all analyses.

Results

The inter- and intra-examiner variations results indicated an extremely high level of reliability with a single measure ICC of 0.997 ~~(95% confidence interval: 0.991,0.999)~~ and 0.983 ~~(95% confidence interval: 0.937, 0.995)~~ respectively. ~~The results between the chronological age and atlas for dental age indicated an extremely high level of agreement with a single measures ICC of 0.970 (95% confidence interval: 0.956, 0.979; p < .001).~~ A paired subjects t-test on the chronological age scores versus atlas for dental age scores resulted in the mean difference of 0.1 (CA: 9.94; ADA: 9.84) and there was no significant difference observed.

There was no significant effect of sex (F (1, 87) = 0.278, p = .600), age group (F (11, 87) = 1.032, p = .426) and the interaction between sex and age group (F (11, 87) = 1.238, p .275) between CA and ADA. The ~~values of the estimation of the variation for the sample pooled~~ difference of ADA by age group can be seen in table 2. The graph (figure 1) shows that subjects whose ADA is greater than CA can be seen above the zero mark and those below presented ADA less than CA.

The results show an inverse correlation in the ages of 4 and 6 for both sexes. The London atlas of tooth development underestimated the ages of 7, 8 and 9 (- 0.5 years) for both females and males. At the age of 10 years old, the difference was of - 1.3 years for females whilst the difference was almost zero for males. Overestimation was noted around the age of 12 and 14 within 0.5 years and underestimation at the age of 15 within 0.5 year. Overall, the results are almost identical in performance. The comparison between CA and ADA by sex can be seen in figure 2.

Figure 1: ~~Error of London Atlas as a function of sex and age in years~~ Difference between ADA and CA according to sex and age group (x=age group; y= difference ~~error~~; female represented by dark grey color and male represented by light grey color).

Figure 2: Comparison between chronological and atlas for dental age (years) by sex.

Table 2: Difference of ADA by age group

Discussion

The London Atlas of tooth development and eruption has been tested in different countries such as Portugal, the Netherlands, the United States, Canada, France, the United Kingdom[8], New Zealand, Spain, Italian, and Saudi Arabian[11]. The results from previous studies presented no statistically significant difference between estimated age and chronological age and the average difference was of +/- 1 year [11, 12].

In this study, the age estimation produced a discrepancy of 1.3 years. Although the differences in age estimation were small among males and females aged 4 to 15 years old, these differences became significant only in the female at the age of 10 years old which presented an underestimation. In general, the permanent dentition in females is completed earlier than in males[13]; therefore, this specific age group has not followed the normal trend. Mean ages are affected by the age constitution of the reference sample and a possible bias is known as age-mimicry[14]; therefore, the results of age estimation methods without fully considering the impact of 'age mimicry' and individual variation[15] might not reflect the real biological profile. Hence, this methodology should be tested in other countries part of the Association of Southeast Asian Nations (ASEAN) community. The limitation of the study was the reduced number of radiographs because children do not usually take radiographs for diagnosis and treatment plan. As a matter of radiation protection, the exposure to ionizing radiation must be kept low in young persons, because their tissues are highly radiosensitive[16]. Further research should test other age ranges using this method in Thai population.

Conclusion

The study indicates that the estimates of dental ages correlate and reasonably reflect the chronological ages of Thai children and adolescents for both males and females from age 4.00 to age 15.99. Moreover, this study provided the reference data of Thai children and adolescents using London Atlas of tooth development and eruption which has not been previously reported in this population.

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Declaration of interest statement

The authors report no conflicts of interest.

References

1. Cattaneo C, Ritz-Timme S, Gabriel P, et al. The difficult issue of age assessment on pedo-pornographic material. Forensic Sci Int. 2009 Jan 10;183(1-3):e21-4. doi: 10.1016/j.forsciint.2008.09.005. PubMed PMID: 19019589; eng.
2. O'Donnell I, C. M. Child Pornography: Crime, Computers and Society. Portland: Willan Publishing; 2007.
3. Moorrees CFA, Fanning EA, Hunt EE. Age Variation of Formation Stages for Ten Permanent Teeth. Journal of Dental Research. 1963 1963/11/01;42(6):1490-1502. doi: 10.1177/00220345630420062701.
4. Lewis A, Garn S. The Relationship Between Tooth Formation and Other Maturational Factors. The Angle Orthodontist. 1960;30(2):70-77. doi: 10.1043/0003-3219(1960)030<0070:Trbtfa>2.0.Co;2.
5. Liversidge HM, Herdeg B, Rösing FW. Dental Age Estimation of Non-Adults. A Review of Methods and Principles. In: Alt KW, Rösing FW, Teschler-Nicola M, editors. Dental Anthropology: Fundamentals, Limits and Prospects. Vienna: Springer Vienna; 1998. p. 419-442.
6. Alsaffar H, Elshehawi W, Roberts G, et al. Dental age estimation of children and adolescents: Validation of the Maltese Reference Data Set. J Forensic Leg Med. 2017 Jan;45:29-31. PubMed PMID: 27918905.
7. Willems G. A review of the most commonly used dental age estimation techniques. J Forensic Odontostomatol. 2001 Jun;19(1):9-17. PubMed PMID: 11494678; eng.
8. AlQahtani SJ, Hector MP, Liversidge HM. Brief communication: The London atlas of human tooth development and eruption. Am J Phys Anthropol. 2010 Jul;142(3):481-90. PubMed PMID: 20310064.
9. Duangto P, Janhom A, Prasitwattanaseree S, et al. New prediction models for dental age estimation in Thai children and adolescents. Forensic Sci Int. 2016 Sep;266:583 e1-583 e5. PubMed PMID: 27264683.
10. Verochana K, Prapayasatok S, Janhom A, et al. Accuracy of an equation for estimating age from mandibular third molar development in a Thai population. Imaging Sci Dent. 2016 Mar;46(1):1-7. PubMed PMID: 27051633.

11. Alshihri AM, Kruger E, Tennant M. Dental age assessment of Western Saudi children and adolescents. Saudi Dent J. 2015 Jul;27(3):131-6. PubMed PMID: 26236126.
12. Pavlovic S, Palmela Pereira C, Vargas de Sousa Santos RF. Age estimation in Portuguese population: The application of the London atlas of tooth development and eruption. Forensic Sci Int. 2017 Mar;272:97-103. PubMed PMID: 28129585.
13. Wedl JS, Schmelzle R, Friedrich RE. [The eruption times of permanent teeth in boys and girls in the Stormarn District, Schleswig-Holstein (Germany)]. Anthropol Anz. 2005 Jun;63(2):189-97. PubMed PMID: 15962569; ger.
14. Tangmose S, Thevissen P, Lynnerup N, et al. Age estimation in the living: Transition analysis on developing third molars. Forensic Sci Int. 2015 Dec;257:512 e1-512 e7. doi: 10.1016/j.forsciint.2015.07.049. PubMed PMID: 26342939; eng.
15. Buckberry J. The (mis)use of adult age estimates in osteology. Ann Hum Biol. 2015;42(4):323-31. doi: 10.3109/03014460.2015.1046926. PubMed PMID: 26190373; eng.
16. Alzen G, Benz-Bohm G. Radiation protection in pediatric radiology. Dtsch Arztebl Int. 2011 Jun;108(24):407-14. PubMed PMID: 21776310.